

Ixodid Ticks (Acarina : Ixodidae) parasitizing wild birds in the Kyasanur Forest disease area of Shimoga District, Mysore State, India

BY

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(With a map and two text-figures)

During a two year study on ticks parasitizing wild birds of Shimoga District, Mysore State, 8474 birds (184 species) were examined and 1082 birds of 81 species were found infested. The genus *Haemaphysalis* accounted for 99.5% of all the ticks collected and the remaining belonged to the genera *Dermacentor*, *Amblyomma*, *Boophilus* and *Hyalomma*. *H. spinigera* was the commonest species of *Haemaphysalis* on birds, closely followed by *H. wellingtoni* and *H. turturis* and nine other species, including a new species *H. megalaimae*. There was no evidence of birds bringing into India, ticks not indigenous to India. The seasonal variations in the infestation by various tick stages and species and the host parasite relationships are also discussed.

INTRODUCTION

During the early part of the investigations on the epidemiology of Kyasanur Forest Disease (KFD), a tick transmitted virus disease affecting men and monkeys in Shimoga District, Mysore State, neutralizing antibodies against KFD virus were found in the sera of several species of wild caught birds [Virus Research Centre (VRC) Annual Report]. Avian involvement in the epidemiology of this disease by their role in the transport of infected ticks, in the maintenance of a tick bird virus cycle and in the dissemination of the virus was suggested by Work (1958). A two-year study on the wild birds of this district was therefore started in December 1959, primarily to study the tick infestation pattern and also incidentally to study the immunity status of these birds against KFD virus. The present communication deals only with the study on the parasitism of birds by ticks.

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There is a lack of published information on any major study on ticks of Indian birds, although references in the literature on intensive studies on ticks of birds in other parts of the world are many. Since the tick species and avian hosts mentioned in these studies are not indigenous to the KFD area, it will not be relevant to detail them here. In India, Sharif (1928) and Sen (1938) have mentioned the parasitism of the domestic fowl by *Haemaphysalis wellingtoni*. Studies on the ticks of migratory birds in Saurashtra and other parts of North Western India conducted by the Bombay Natural History Society have shown the parasitism of many birds by several tick species. Hoogstraal & Trapido (1963a) have recorded *Haemaphysalis kutchensis* nymphs from a variety of ground feeding birds in Kutch, Gujarat State. Dhanda (1964) had collected nymphs of *H. howletti* from the Crow Pheasant, *Centropus sinensis*. All the stages of *H. centropi* were also collected from the same host species (Dhanda, personal communication). Dhanda & Rao (1964) in their report on tick collections made in North East Frontier Agency of India had reported the presence of nymphs of *Amblyomma testudinarium* and *Haemaphysalis formosensis* on the Red Junglefowl, *Gallus gallus*. Rebello & Reuben (1967) in a recent study examined 590 birds belonging to 55 species in Vellore, Madras State, and had collected ticks from 136 birds belonging to 16 species. The tick species collected were *Haemaphysalis intermedia*, *H. bispinosa*, and *Hyalomma marginatum isaaci*, all of which were taken on birds during the present study.

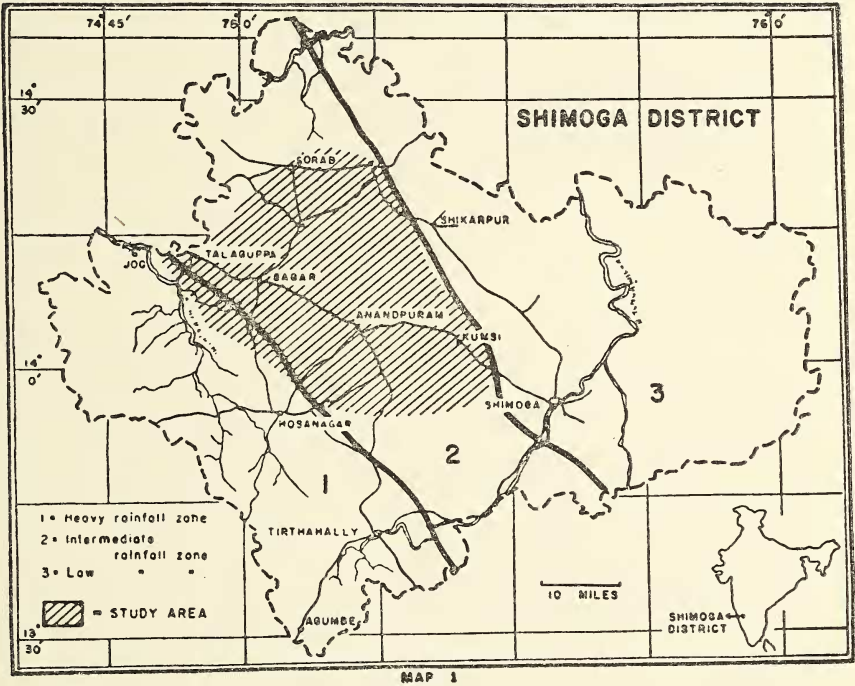
The study area has been described by several authors in great detail (Trapido *et al.* 1964a; Rajagopalan, *et al.* 1968a and Boshell 1969). It is situated in Shimoga District, between latitudes 13° 30' and 14° 45' N. and longitudes 74° 30' and 76° 15' E. and can be roughly divided into three main zones of heavy, intermediate and low rainfall (Map). Most of the host sample was collected from the intermediate rainfall zone which has an annual rainfall of 1524-2540 mm. per year and comprises the KFD infected areas of Sagar and Sorab taluks. The country is a gently undulating one at an elevation of about 600 metres above sea level and is mostly covered by semi-deciduous rain forest. Most of the rainfall takes place during the four monsoon months from June to September. A vast forest cover with arecanut and banana plantations and paddy fields interspersed with numerous scattered villages is the characteristic feature of this area.

MATERIALS AND METHOD

Collection and identification of birds :

During the early part of the study, birds were obtained by trapping them in nylon mist nets. Since mistnet trapping was not very productive

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and since the object was to collect and examine at least 300 birds every month, shooting was resorted to, with a 410 Savage shotgun using no. 9 shots. Each bird, after proper labelling, was individually wrapped in lint and taken to the field laboratory. Identifications of birds were made with the help of descriptions given by Sálím Ali (1942, 1943, 1949, 1953, 1955) and Whistler (1949) which also provided useful information on migratory status and nesting habits of birds. Birds with doubtful or unknown identity were skinned and were later identified by the Bombay Natural History Society. The scientific names of birds used in this paper are those given by Ripley (1961).

Collection and identification of ticks :

Each bird was carefully examined with a magnifying glass and the ticks collected were preserved in 70 per cent alcohol for later identification. Initially, the immature stages of ticks were given arbitrary type numbers. The final identification of ticks was done with the help of a key by Trapido *et al.* (1964b).

RESULTS

The host sample :

During the two-year period December 1959 to November 1961, 8474 birds belonging to 184 species were examined for ticks, of which 416 birds belonging to 25 species were listed as migrants by Ripley (1961). A total of 1082 birds belonging to 81 species had ticks on them. The number of birds examined in different months during the two year period is given in Table 1. The largest number (927) was in November and the smallest number in June (400). The largest number of birds found positive for ticks was also in November (205) and the smallest number in June (28).

Birds which were examined and found negative for ticks are listed below, with the number of each species examined in parenthesis. *Podiceps ruficollis* (2); *Phalacrocorax carbo* (2); *Ardea cinerea* (1); *Ardeola grayii* (120); *Bubulcus ibis* (92); *Egretta alba* (3); *Egretta garzetta* (8); *Gorsachius melanolophus* (2); *Ixobrychus cinnamomeus* (1); *Dendrocygna javanica* (48); *Anas crecca* (1); *Anas poecilorhyncha* (2); *Nettapus coromandelianus* (35); *Milvus migrans* (3); *Haliastur indus* (5); *Accipiter virgatus* (2); *Butastur teesa* (1); *Aquila rapax* (3); *Torgos calvus* (1); *Gyps bengalensis* (1); *Neophron percnopterus* (4); *Spilornis cheela* (4); *Falco tinnunculus* (4); *Turnix tanki* (1); *Rallus striatus* (1); *Gallinula chloropus* (2); *Porphyrio porphyrio* (8); *Fulica atra* (7); *Hydrophasianus chirurgus* (1); *Metopidius indicus* (35); *Tringa ochropus* (15); *Tringa hypoleucos* (8); *Capella gallinago* (3); *Ducula aenea* (60); *Columba livia* (8); *Streptopelia orientalis* (4); *Streptopelia chinensis*

(261); *Psittacula cyanocephala* (58); *Clamator jacobinus* (12); *Cacomantis merulinus* (1); *Surniculus lugubris* (2); *Athene brama* (4); *Caprimulgus indicus* (2); *Hemiprocne longipennis* (11); *Harpactes fasciatus* (14); *Alcedo atthis* (9); *Pelargopsis capensis* (9); *Halcyon smyrnensis*

TABLE 1

SUMMARY OF MONTHLY INFESTATION OF BIRDS BY TICKS DURING THE TWO-YEAR STUDY (December 1959-November 1961)

Months	I Year (Dec. 59-Nov. 60)			II Year (Dec. 60-Nov. 61)			Both years combined		
	Number Examined	No. +ve for ticks	Percentage infestation	Number Examined	No. +ve for ticks	Percentage infestation	Number Examined	No. +ve for ticks	Percentage infestation.
December	520	65	12.5	373	46	12.3	893	111	12.4
January	322	46	14.3	353	51	14.4	675	97	14.3
February	532	56	10.5	419	69	16.4	951	125	13.1
March	323	20	6.3	371	69	18.6	694	89	12.8
April	377	27	7.2	330	53	16.0	707	80	11.3
May	365	21	5.9	353	35	9.9	718	56	7.7
June	256	14	5.4	144	14	9.7	400	28	7.0
July	362	23	6.3	175	16	9.0	537	39	7.2
August	318	23	7.2	215	20	9.2	533	43	8.0
September	280	11	3.9	336	22	6.5	616	33	5.3
October	428	89	20.8	395	87	22.0	823	176	21.3
November	616	125	20.3	311	80	25.7	927	205	22.1
Total	4699	520	11.07	3775	562	14.8	8474	1082	12.7

(22); *Merops leschenaulti* (32); *Merops philippinus* (1); *Merops orientalis* (71); *Nyctornis athertoni* (4); *Anthraceroceros coronatus* (3); *Megalaima zeylanica* (5); *Jynx torquilla* (1); *Picumnus innominatus* (2); *Micropternus brachyurus* (16); *Picus chlorolophus* (15); *Dendrocopos maharattensis* (6); *Dendrocopos nanus* (11); *Hirundo rustica* (10); *Hirundo smithii* (18); *Hirundo daurica* (26); *Lanius excubitor* (14); *Oriolus chinensis* (1); *Artamus fuscus* (34); *Dendrocitta leucogastra* (14); *Corvus splendens* (8); *Hemipus picatus* (14); *Coracina novaehollandiae* (5); *Aegithina tiphia* (91); *Pycnonotus priocephalus* (7); *Pycnonotus melanicterus* (16); *Hypsipetus indicus* (57); *Rhopocichla atriceps* (26); *Muscicapa pallipes* (5); *Muscicapa thalassina* (4); *Cuclicicapa ceylonensis* (7); *Monarcha azurea* (11); *Prinia socialis* (1); *Muscicapa latirostris* (4); *Muscicapa parva* (3); *Orthotomus sutorius* (29); *Schoenicola platyura* (2); *Acrocephalus agricola* (3); *Sylvia curruca* (2); *Erithacus svecicus* (1); *Erithacus brunneus* (1); *Monticola cinclorhynchus* (1); *Parus major* (3); *Sitta frontalis* (11); *Anthus novaeseelandiae*

(1); *Motacilla indica* (2); *Motacilla alba* (10); *Dicaeum agile* (18); *Nectarinia zeylonica* (32); *Nectarinia asiatica* (17); *Arachnothera longirostris* (3); *Zosterops palpebrosa* (2); *Ploceus philippinus* (29); *Lonchura malabarica* (1); *Lonchura keelarti* (11); *Lonchura malacca* (55).

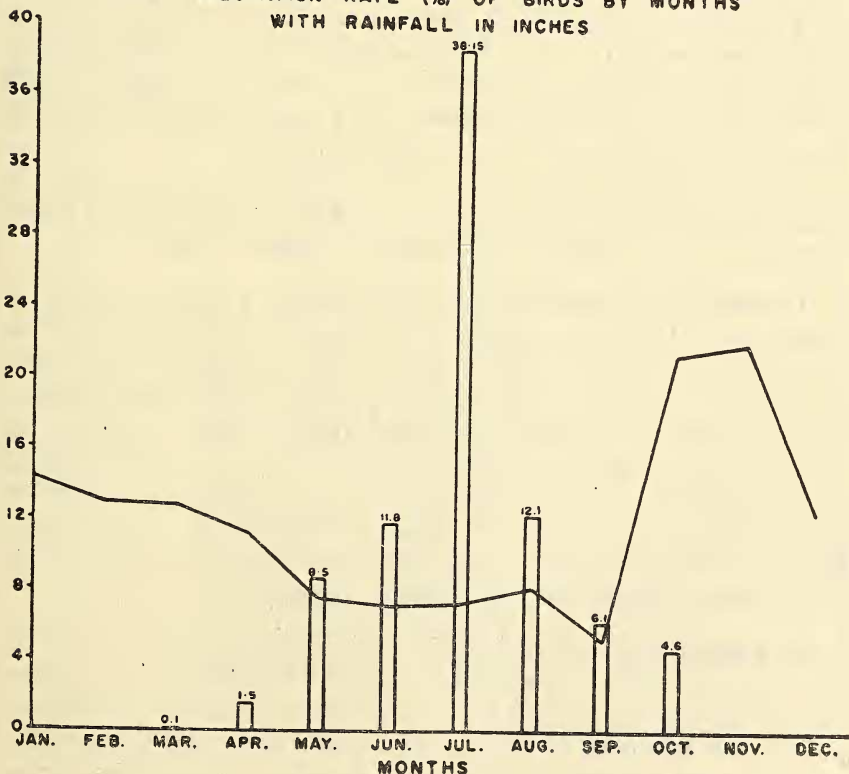
Among the species listed above are those which are aquatic and those which frequent tank bunds, mud flats and irrigated fields. Many arboreal and terrestrial species have also been found negative for ticks, though sizable numbers of them were examined at a time of the year when most of the other bird species were found infested with ticks.

Birds of the family Phasianidae had the highest rate of infestation (87.5%). The other families of birds showing high tick infestation rates were Cuculidae (Crow Pheasant), Muscicapidae (Babblers, Thrush etc.), Sturnidae (Mynas) and Motacillidae (Wagtails). Birds of these families are either ground living or ground frequenting.

The highest rate of infestation as well as the largest number of birds found positive for ticks in any month are in November (Fig. 1) and this month along with October corresponds with the season of predominance of tick larvae on the forest floor. During the monsoon months from

FIG. 1

TICK INFESTATION RATE (%) OF BIRDS BY MONTHS
WITH RAINFALL IN INCHES



June to September the tick infestation rate in birds is very low and this season corresponds with the predominance of adult ticks in the forest and the almost complete inactivity and scarcity of immature tick stages.

The tick sample :

The ticks collected from birds during the two year study were of six genera in the family Ixodidae. Though two species of *Ixodes*, namely *I. petauristae* and *I. ceylonensis* are common in the study area, no *Ixodes* was found on any bird.

In all, 9821 ticks belonging to six genera and 17 species were collected (Table 2). More than 99 per cent of all the ticks collected (9774) belonged to the genus *Haemaphysalis* and comprised 12 of the 14 species of this genus recorded in the study area. The two species not found on birds were *H. cornigera shimoga* and *H. canastrini* group (formerly *H. leachi*). The remaining 47 ticks (0.5 per cent of the total) belonged to the genera *Dermacentor*, *Rhipicephalus*, *Amblyomma*, *Boophilus* and *Hyalomma*.

The most dominant species of *Haemaphysalis* collected on birds was *spinigera*, which formed 74.1 per cent of all ticks belonging to this genus. The other species, in order of their abundance, were *H. wellingtoni* (10.9%), *H. turturis* (6.2%), *H. bispinosa* (3.9%), *H. intermedia* (1.6%), *H. papuana kinneari* (1.5%), *H. kysanurensis* (0.6%), and *H. minuta* (0.4%). *H. megalaimae* was found only on one host species. Small numbers of *H. cuspidata*, *H. aculeata* and a single specimen of *H. centropi* were also collected on birds during this study.

The various bird species found positive for ticks and the number of different stages of each species collected on birds are presented on Tables 3 and 4, and the individual tick species are discussed below.

H. spinigera is commonest of all ticks found in ground drags and on vegetation in the study area and has been collected from 715 birds belonging to 69 species. Thirty-two per cent of all *spinigera* was taken on the Crow Pheasant, *Centropus sinensis* and 33% on the Jungle Babbler, *Turdoides striatus*. *Acridotheres fuscus*, Jungle Myna, accounted for 12% and the Jungle fowl, *Gallus sonneratii* for 9%. The remaining 14% were found on 65 species of birds. Larvae were found on 35 species and nymphs on 42 species. Of the six adults collected, five were from *Gallus sonneratii* and one from *Acridotheres fuscus*. All the adults were teneral and apparently not feeding on the hosts.

H. wellingtoni is a recognized bird ectoparasite but was not encountered in large numbers in ground drags or on vegetation. The number and variety of birds infested by this tick were second only to *spinigera* as 292 birds belonging to 39 species were positive for this tick. Eighty per cent of all *wellingtoni* was collected from three host species, *Gallus*

TABLE 2
NUMBER OF TICKS COLLECTED ON BIRDS, BY SPECIES AND STAGES, WITH THE NUMBER OF HOSTS POSITIVE FOR EACH SPECIES

	Number of host species positive	Number of birds positive	Larvae	No. of ticks Nymphs	Collected Adults	Total
1. <i>Haemaphysalis spinigera</i> Neumann, 1897	..	69	715	6119	6	7244
2. <i>Haemaphysalis wellingtoni</i> Nuttall and Warburton, 1907	..	39	292	672	148	1073
3. <i>Haemaphysalis turturis</i> Nuttall and Warburton, 1915	..	24	144	332	10	609
4. <i>Haemaphysalis bispinosa</i> Neumann, 1897	..	24	113	303	2	389
5. <i>Haemaphysalis intermedia</i> Warburton and Nuttall, 1909	..	15	75	116	16	155
6. <i>Haemaphysalis papuana kinneari</i> Warburton, 1913	..	15	41	119	0	136
7. <i>Haemaphysalis kysanurensis</i> Trapido, Hoogstraal and Rajagopalan, 1964	..	11	22	27	0	55
8. <i>Haemaphysalis minuta</i> Kohls, 1950	..	6	24	3	12	39
9. <i>Haemaphysalis megalinae</i> Rajagopalan, 1963	..	1	13	1	27	44
10. <i>Haemaphysalis aculeata</i> Lavarra, 1905	..	6	11	4	0	16
11. <i>Haemaphysalis cuspidata</i> Warburton, 1910	..	4	9	6	1	13
12. <i>Haemaphysalis centropi</i> Kohls, 1949	..	1	1	0	1	1
All <i>Haemaphysalis</i> ticks	..		7702	1849	223	9774
13. <i>Dermacentor auratus</i> Supino, 1897	..		16	0	0	16
14. <i>Rhipicephalus</i> sp.	..		15	1	0	16
15. <i>Amblyomma</i> sp.	..		5	8	0	13
16. <i>Boophilus</i> sp.	..		1	0	0	1
17. <i>Hyalomma marginatum isaaci</i> Sharif, 1928	..		0	1	0	1
Grand Total :			37	10	0	47
			7739	1859	223	9821

Haemaphysalis TICKS COLLECTED FROM DIFFERENT

L : LARVAE, N : NYMPHS,

Species of Birds found positive for ticks	No. birds +/ No. examined	<i>spingera</i> L/N/Ad	<i>wellingtoni</i> L/N/Ad	<i>turturis</i> L/N/Ad
1	2	3	4	5
1. <i>Accipiter badius</i> ..	5/32	0/6/0	0/1/0	—
2. <i>Circetus gallicus</i> ..	1/1	0/1/0	0/0/1	—
3. <i>Galloperdix spadicea</i> ..	2/3	0/16/0	1/4/0	0/3/0
4. <i>Gallus sonneratii</i> ..	23/25	450/226/5	122/107/44	102/161/7
5. <i>Pavo cristatus</i> ..	1/1	—	12/15/0	0/2/0
6. <i>Amaurornis phoenicurus</i> ..	1/6	—	2/0/0	—
7. <i>Vanellus indicus</i> ..	1/21	—	—	—
8. <i>Vanellus malabaricus</i> ..	1/24	—	1/0/0	—
9. <i>Charadrius dubius</i> ..	2/15	1/1/0	—	—
10. <i>Treron pompadora</i> ..	1/109	1/1/0	—	—
11. <i>Treron phoenicoptera</i> ..	1/63	0/1/0	—	—
12. <i>Chalcophaps indica</i> ..	1/17	—	—	—
13. <i>Psittacula columboides</i> ..	2/93	0/1/0	—	—
14. <i>Loriculus vernalis</i> ..	2/61	1/0/0	—	0/1/0
15. <i>Centropus sinensis</i> ..	129/151	2194/202/0	226/57/92	120/47/2
16. <i>Eudynamis scolopacea</i> ..	2/74	—	1/1/0	—
17. <i>Rhopodytes viridirostris</i> ..	2/31	3/0/0	—	—
18. <i>Coracias benghalensis</i> ..	2/23	—	—	—
19. <i>Upupa epops</i> ..	2/10	2/0/0	—	—
20. <i>Tockus griseus</i> ..	6/80	1/0/0	0/0/2	2/0/0
21. <i>Megalaima viridis</i> ..	15/297	1/1/0	—	—
22. <i>Megalaima rubricapilla</i> ..	2/152	2/0/0	—	—
23. <i>Dinopium benghalense</i> ..	12/162	8/2/0	—	1/2/0
24. <i>Drycopus javensis</i> ..	2/14	1/0/0	—	—
25. <i>Hemicircus canente</i> ..	1/48	1/0/0	—	—
26. <i>Pitta brachyura</i> ..	5/13	25/8/0	—	—
27. <i>Mirafra erythroptera</i> ..	3/16	1/0/0	1/0/0	1/0/0
28. <i>Galeridia malabarica</i> ..	7/108	2/0/0	3/0/0	—
29. <i>Alauda gulgula</i> ..	3/59	—	1/0/0	—
30. <i>Lanius vittatus</i> ..	1/10	1/0/0	—	—
31. <i>Lanius schach</i> ..	6/29	21/0/0	—	2/0/0
32. <i>Lanius cristatus</i> ..	1/6	40/0/0	—	—
33. <i>Oriolus oriolus</i> ..	3/78	4/0/0	—	—
34. <i>Oriolus xanthornus</i> ..	1/28	1/0/0	—	—
35. <i>Dicrurus adsimilis</i> ..	14/146	22/4/0	—	—
36. <i>Dicrurus leucophaeus</i> ..	1/80	1/0/0	—	—
37. <i>Dicrurus caerulescens</i> ..	4/20	7/0/0	12/0/0	—
38. <i>Dicrurus hottentottus</i> ..	1/2	2/0/0	—	—
39. <i>Dicrurus paradiseus</i> ..	3/49	4/0/0	1/0/0	0/1/0
40. <i>Sturnus malabaricus</i> ..	3/107	3/1/0	—	—
41. <i>Sturnus pagodarum</i> ..	10/95	1/0/0	1/2/0	3/0/0
42. <i>Sturnus roseus</i> ..	4/128	1/1/0	0/1/0	—
43. <i>Acridotheres tristis</i> ..	61/416	108/10/0	20/4/1	4/9/0
44. <i>Acridotheres fuscus</i> ..	159/787	773/95/1	25/11/0	15/8/0
45. <i>Gracula religiosa</i> ..	3/246	0/3/0	—	—
46. <i>Corvus macrorhynchos</i> ..	4/30	6/3/0	1/0/0	—

3

BIRDS, BY SPECIES AND STAGES

Ad : ADULTS

[illegible]

TABLE

Haemaphysalis TICKS COLLECTED FROM DIFFERENT

L : LARVAE, N : NYMPHS,

Species of Birds found positive for ticks	No. birds + / No. examined	<i>spinigera</i> L/N/Ad	<i>wellingtoni</i> L/N/Ad	<i>turturis</i> L/N/Ad
1	2	3	4	5
47. <i>Tephrodornis virgatus</i> ..	4/105	4/0/0	1/1/0	—
48. <i>Tephrodornis pondicerianus</i> ..	6/84	5/1/0	—	—
49. <i>Coracina melanoptera</i> ..	5/69	3/2/0	2/0/0	—
50. <i>Pericrocotus flammeus</i> ..	2/193	1/0/0	0/0/1	—
51. <i>Pericrocotus cinnamomeus</i> ..	2/37	2/0/0	—	—
52. <i>Chloropsis aurifrons</i> ..	1/35	0/1/0	—	—
53. <i>Chloropsis cochinchinensis</i> ..	2/47	1/1/0	—	—
54. <i>Irena puella</i> ..	3/62	2/1/0	—	1/0/0
55. <i>Pycnonotus jocosus</i> ..	22/463	23/5/0	1/0/0	—
56. <i>Pycnonotus cafer</i> ..	4/109	4/0/0	2/0/0	—
57. <i>Pycnonotus luteolus</i> ..	1/42	0/1/0	—	—
58. <i>Pellorneum ruficeps</i> ..	12/32	4/15/0	0/2/0	—
59. <i>Pomatorhinus schisticeps</i> ..	3/29	1/0/0	1/0/0	—
60. <i>Turdoides subrufus</i> ..	7/16	0/4/0	—	2/0/0
61. <i>Turdoides striatus</i> ..	267/447	2024/363/0	130/26/0	66/21/0
62. <i>Turdoides affinis</i> ..	53/75	124/34/0	23/5/0	0/1/0
63. <i>Muscicapa tickelliae</i> ..	1/41	0/1/0	—	—
64. <i>Rhipidura albogularis</i> ..	1/1	3/1/0	—	1/0/0
65. <i>Terpsiphone paradisi</i> ..	1/1	0/1/0	—	—
66. <i>Prinia sylvatica</i> ..	2/7	4/0/0	0/1/0	—
67. <i>Acrocephalus stentoreus</i> ..	1/1	—	0/1/0	—
68. <i>Acrocephalus dumetorum</i> ..	14/83	17/5/0	0/1/0	—
69. <i>Copsychus saularis</i> ..	86/332	117/69/0	19/6/1	6/7/0
70. <i>Copsychus malabaricus</i> ..	5/67	3/1/0	0/1/0	0/1/0
71. <i>Saxicola caprata</i> ..	2/20	—	0/2/0	—
72. <i>Saxicoloides fulicata</i> ..	2/7	0/1/0	0/1/0	—
73. <i>Zoothera citrina</i> ..	26/68	56/18/0	13/2/5	2/2/1
74. <i>Zoothera dauma</i> ..	1/10	0/1/0	—	1/0/0
75. <i>Turdus merula</i> ..	9/45	16/7/0	3/1/1	0/1/0
76. <i>Parus xanthogenys</i> ..	1/50	1/0/0	—	—
77. <i>Motacilla caspica</i> ..	11/97	12/1/0	—	3/0/0
78. <i>Motacilla maderaspatensis</i> ..	5/40	2/3/0	—	—
79. <i>Passer domesticus</i> ..	1/17	—	—	—
80. <i>Petronia xanthocollis</i> ..	2/41	—	7/0/0	—
81. <i>Lonchura striata</i> ..	1/33	2/0/0	—	—
6120/1120/6 632/253/148 332/267/10				

sonneratii, *Centropus sinensis* and *Turdoides striatus*. Nearly two-thirds of all adults taken on birds belong to *wellingtoni* and was taken on nine host species.

H. turturis all stages have been taken in the study area in ground drags and on vegetation in numbers second only to *H. spinigera*. This

3

BIRDS, BY SPECIES AND STAGES—(Contd.)

AD: ADULTS

<i>bispinosa</i>	<i>intermedia</i>	<i>papuana</i> <i>kinneare</i>	<i>kyasanu-</i> <i>rensis</i>	<i>minuta</i>	<i>megalaimae</i>	<i>aculeata</i>	<i>cuspidata</i>	<i>centropi</i>
L/N/Ad	L/N/Ad	L/N	L/N	L/N/Ad	L/N/Ad	L/N	L/N/Ad	Ad
6	7	8	9	10	11	12	13	14
—	—	—	—	—	—	—	—	—
—	—	—	—	—	—	—	—	—
—	—	—	—	—	—	—	—	—
—	—	—	—	—	—	—	—	—
—	0/ 1/ 0	—	—	—	—	—	—	—
1/0/0	—	—	—	—	—	—	—	—
—	—	—	—	—	—	—	—	—
—	—	—	0/1	—	—	1/0	—	—
—	—	1/0/0	—	—	—	—	—	—
1/0/0	—	3/0/0	0/8	—	—	—	—	—
38/4/0	24/4/0	26/2/0	4/5	1/5/0	—	1/0	—	—
3/0/0	6/6/0	—	0/1	0/1/0	—	—	—	—
—	—	—	—	—	—	—	—	—
—	—	—	—	—	—	—	—	—
—	—	—	—	—	—	—	—	—
—	—	—	—	—	—	—	—	—
—	—	—	—	—	—	—	—	—
1/0/0	—	2/1/0	2/0	—	—	—	—	—
6/2/0	4/5/0	29/1/0	—	0/2/0	—	—	1/0/0	—
—	—	—	—	—	—	—	—	—
—	—	—	—	—	—	—	—	—
—	—	—	—	—	—	—	—	—
2/0/0	0/1/1	13/0/0	1/0	0/2/0	—	0/1	—	—
—	1/0/0	1/0/0	2/0	—	—	—	—	—
—	—	—	—	—	—	—	—	—
20/0	—	1/0/0	—	—	—	—	—	—
—	—	—	—	—	—	—	—	—
1/0/0	—	—	—	—	—	—	—	—
—	5/0/0	—	—	—	—	—	—	—
—	—	—	—	—	—	—	—	—
—	—	—	—	—	—	—	—	—
303/84/2	116/23/16	119/17/0	27/28	3/24/12	1/16/27	4/12	6/6/1	1

tick has been collected from 144 birds belonging to 24 species. Eighty per cent of all *turturis* collected on birds, were from five species of ground frequenting birds, *Gallus sonneratii*, *Centropus sinensis*, *Acridotheres fuscus*, *Turdoides striatus* and *Copsychus saularis*. Though *H. turturis* was originally described from a male collected from a dove, *Turtur suratensis*, in Ceylon, other records of adult hosts are all from mammals.

TABLE

Haemaphysalis TICKS COLLECTED FROM DIFFERENT

L: LARVAE, N: NYMPHS,

Species of Birds found positive for ticks	No. birds + No. examined	spinigera L/N/Ad	wellingtoni L/N/Ad	turturis L/N/Ad
1	2	3	4	5
47. <i>Tephrodornis virgatus</i> ..	4/105	4/0/0	1/1/0	—
48. <i>Tephrodornis pondicerianus</i> ..	6/84	5/1/0	—	—
49. <i>Coracina melanoptera</i> ..	5/69	3/2/0	2/0/0	—
50. <i>Pericrocotus flammeus</i> ..	2/193	1/0/0	0/0/1	—
51. <i>Pericrocotus cinnamomeus</i> ..	2/37	2/0/0	—	—
52. <i>Chloropsis aurifrons</i> ..	1/35	0/1/0	—	—
53. <i>Chloropsis cochinchinensis</i> ..	2/47	1/1/0	—	—
54. <i>Irena puella</i> ..	3/62	2/1/0	—	1/0/0
55. <i>Pycnonotus jocosus</i> ..	22/463	23/5/0	1/0/0	—
56. <i>Pycnonotus cafer</i> ..	4/109	4/0/0	2/0/0	—
57. <i>Pycnonotus luteolus</i> ..	1/42	0/1/0	—	—
58. <i>Pellorneum ruficeps</i> ..	12/32	4/1/0	0/2/0	—
59. <i>Pomatorhinus schisticeps</i> ..	3/29	1/0/0	1/0/0	—
60. <i>Turdoides subrufus</i> ..	7/16	0/4/0	—	2/0/0
61. <i>Turdoides striatus</i> ..	267/447	2024/363/0	130/26/0	66/21/0
62. <i>Turdoides affinis</i> ..	53/75	124/34/0	23/5/0	0/1/0
63. <i>Muscicapa fleckelliae</i> ..	1/41	0/1/0	—	—
64. <i>Rhipidura albogularis</i> ..	1/1	3/1/0	—	1/0/0
65. <i>Terpsiphone paradisi</i> ..	1/1	0/1/0	—	—
66. <i>Prinia sylvatica</i> ..	2/7	4/0/0	0/1/0	—
67. <i>Acrocephalus stentoreus</i> ..	1/1	—	0/1/0	—
68. <i>Acrocephalus dumetorum</i> ..	14/83	17/5/0	0/1/0	—
69. <i>Copsychus saularis</i> ..	86/332	117/69/0	19/6/1	6/7/0
70. <i>Copsychus malabaricus</i> ..	5/67	3/1/0	0/1/0	0/1/0
71. <i>Saxicola caprata</i> ..	2/20	—	0/2/0	—
72. <i>Saxicoloides fulicata</i> ..	2/7	0/1/0	0/1/0	—
73. <i>Zoothera citrina</i> ..	26/68	56/18/0	13/2/5	2/2/1
74. <i>Zoothera dauma</i> ..	1/10	0/1/0	—	1/0/0
75. <i>Turdus merula</i> ..	9/45	16/7/0	3/1/1	0/1/0
76. <i>Parus xanthogenys</i> ..	1/50	—	—	—
77. <i>Motacilla caspica</i> ..	11/97	12/1/0	—	3/0/0
78. <i>Motacilla naderaspatis</i> ..	5/40	2/3/0	—	—
79. <i>Passer domesticus</i> ..	1/17	—	—	—
80. <i>Petronia xanthocollis</i> ..	2/41	—	7/0/0	—
81. <i>Lonchura striata</i> ..	1/33	2/0/0	—	—
6120/1120/6 632/253/148 332/267/10				

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H. turturis all stages have been taken in the study area in ground drags and on vegetation in numbers second only to *H. spinigera*. This

3

BIRDS, BY SPECIES AND STAGES—(Contd.)

AD: ADULTS

<i>bispinosa</i> L/N/Ad	<i>intermedia</i> L/N/Ad	<i>papuanus</i> <i>kincaid</i> L/N	<i>kyasanu-</i> <i>rensis</i> L/N	<i>minuta</i> L/N/Ad	<i>megalaemus</i> L/N/Ad	<i>aculeata</i> L/N	<i>cuspidata</i> L/N/Ad	<i>centropi</i> Ad
6	7	8	9	10	11	12	13	14
—	—	—	—	—	—	—	—	—
—	—	—	—	—	—	—	—	—
—	—	—	—	—	—	—	—	—
—	—	—	—	—	—	—	—	—
—	0/ 1/ 0	—	—	—	—	—	—	—
1/0/0	—	—	—	—	—	—	—	—
—	—	—	—	—	—	—	—	—
—	—	—	0/1	—	—	—	—	—
—	—	1/0/0	—	—	—	1/0	—	—
—	—	3/0/0	0/8	—	—	—	—	—
38/4/0	24/4/0	26/2/0	4/5	1/5/0	—	1/0	—	—
3/0/0	6/6/0	—	0/1	0/1/0	—	—	—	—
—	—	—	—	—	—	—	—	—
—	—	—	—	—	—	—	—	—
—	—	—	—	—	—	—	—	—
1/0/0	—	2/1/0	2/0	—	—	—	—	—
6/2/0	4/5/0	29/1/0	—	0/2/0	—	—	1/0/0	—
—	—	—	—	—	—	—	—	—
—	—	—	—	—	—	—	—	—
2/0/0	0/1/1	13/0/0	1/0	0/2/0	—	0/1	—	—
—	1/0/0	1/0/0	2/0	—	—	—	—	—
20/0	—	1/0/0	—	—	—	—	—	—
1/0/0	—	—	—	—	—	—	—	—
—	5/0/0	—	—	—	—	—	—	—
—	—	—	—	—	—	—	—	—
303/84/2	116/23/16	119/17/0	27/28	3/24/12	1/16/27	4/12	6/6/1	1

tick has been collected from 144 birds belonging to 24 species. Eighty per cent of all *turturis* collected on birds, were from five species of ground frequenting birds, *Gallus sonneratii*, *Centropus sinensis*, *Acridotheres fuscus*, *Turdoides striatus* and *Copsychus saularis*. Though *H. turturis* was originally described from a male collected from a dove, *Turtur surdatensis*, in Ceylon, other records of adult hosts are all from mammals.

In KFD area also, this species was found to be a wild mammal tick in adult stages (Rajagopalan *et al.* 1968b). The ten adults taken in this study were all teneral and not actually attached on the hosts.

H. bispinosa is primarily an ectoparasite of cattle and the immature stages have been taken in small numbers in ground drags and a few adults have also been collected from vegetation. In all, 113 birds belonging to 24 species were found infested with this species. More than 80 per cent of all *bispinosa* was collected from four species of birds, *Pavo cristatus*, *Gallus sonneratii*, *Centropus sinensis* and *Turdoides striatus*.

H. intermedia was formerly referred as *H. parva* in literature (Hoogstraal & Trapido 1963b). Though Sharif (1928) mentions that this species 'usually attacks wild animals and consequently of no economic importance', the adults of this species are common ectoparasites, principally of sheep and goats but also of cattle in the relatively dry open country 'maidan' in India. This tick is not usually encountered in ground drags in the study area, though 75 birds belonging to 15 species were found infested with various stages of this species of tick. More than a third of all *intermedia* taken were from the Crow Pheasant, *Centropus sinensis*. This host species also accounts for 15 of the 16 adults of *intermedia* in the sample. *H. intermedia* number the third largest among all *Haemaphysalis* adults on birds, in this study, after the common bird tick *H. wellingtoni* and the host specific *H. megalaimae*.

H. papuana kinneari is one of the common species found on ground drags and forest vegetation in KFD area, next in abundance only to *H. spinigera* and *H. turturis*. Adults are primarily parasitic on wild large mammals like the wild boar, *Sus scrofa*. In this study 136 larvae and nymphs of this species were taken on 41 birds of 15 species and nearly 90% of the ticks were collected from five species of ground frequenting birds.

H. kysanurensis is a species with apparently restricted distribution in the western parts of India and belongs to *H. formosensis* group (Trapido *et al.* 1964c). It is fairly common in the study area, the adults of which chiefly parasitizing wild animals like *Hystrix indica*, *Canis aureus* etc. Larvae and nymphs of this species have been taken on 22 birds belonging to five species. It is one of the less common species of *Haemaphysalis* parasitizing birds in KFD area.

H. minuta was first described by Kohls (1950) from males collected off jungle fowls in Ceylon. Nymphs and adults of this species have been taken in small numbers from ground drags and vegetation in the

study area. In the present study 24 birds belonging to nine species were found infested and 22 of the 39 ticks collected were from the jungle fowl, *Gallus sonneratii*. All the 12 adults collected were also from the jungle fowl which appears to be the preferred host of this tick.

H. megalaimae, a rare tick species, was found parasitizing exclusively the Small Green Barbet, *Megalaima viridis*, and was never obtained from ground drags or on any other host species in the study area. Thirteen birds of this species out of a total of 297 examined were found positive for this tick. This tick belongs to the *centropihoodi* group of bird parasitizing haemaphysalids (Rajagopalan 1963). According to Hume (1890) the barbet nests in tree holes excavating their own holes. They do not always make a fresh nest hole, sometimes taking possession of a hole used the year before. They usually occupy the hole to roost all round the year. This affords a reasonable explanation for the maintenance of the life cycle of *H. megalaimae* either on the bird or in the nest hole. This tick has not been found on any other bird with tree hole nesting habits and hence this appears to be a case of extreme host specificity. Nymphs and adults of this tick were found on the bird in both dry season and monsoon. The single larva collected was in the month of April.

H. aculeata : The nymphs and adults of this species parasitize wild ungulates like spotted deer (*Axis axis*), mouse deer (*Tragulus meminna*) etc. It has been encountered only in very small numbers in ground drags. Sixteen larvae and nymphs were found on eleven birds belonging to six species. It appears that birds are only adventitious hosts for the immature stages of this mammal tick.

H. cuspidata : Like *H. aculeata*, the adults of this species are common ectoparasites of spotted deer and mouse deer in KFD area and all stages have been taken in small numbers in ground drags and on vegetation. Nine birds of four species were positive for this tick, ten of the 13 ticks collected being from the crow pheasant, *Centropus sinensis*.

H. centropi : A rare species in the study area, it has never been collected in ground drags or vegetation. Only one male was collected on a common myna, *Acridotheres tristis*. Originally described from birds of the genus *Centropus*, it was not collected on any of the 151 *Centropus sinensis* examined during this study. This might possibly be a reflection of the geographical limits of parasitism exhibited by the species, as this species has been collected in the drier area about 400 miles north of the study area.

Genera other than *Haemaphysalis* : The five genera other than the genus *Haemaphysalis* account for less than 0.5% of the total ticks collected in the study area from birds. These and their hosts are listed in

TABLE 4

NUMBER AND STAGES OF TICKS OTHER THAN *Haemaphysalis* COLLECTED FROM BIRDS

Species of Bird	No. +ve for ticks other than <i>Haemaphysalis</i>	No. positive for all ticks	No. of birds examined	<i>Dermacentor auratus</i>		<i>Rhipicephalus</i> sp.		<i>Amblyomma</i> sp.		<i>Boophilus</i> sp.		<i>Hyalomma m. isaaci</i>	Total number of all stages of ticks.
				L	N	L	N	L	N	L	N		
1. <i>Gallus sonneratii</i> ..	4	23	25	1	—	—	—	3	—	—	—	—	5
2. <i>Centropus sinensis</i> ..	3	129	151	4	—	—	—	1	2	—	—	—	7
3. <i>Upupa epops</i> ..	2	2	10	—	—	2	—	1	—	—	—	—	3
4. <i>Tockus griseus</i> ..	1	6	80	1	—	—	—	—	—	—	—	—	1
5. <i>Lanius schach</i> ..	1	6	29	—	—	1	—	—	—	—	—	—	1
6. <i>Sturnus pagodarum</i> ..	1	10	95	1	—	—	—	—	—	—	—	—	1
7. <i>Sturnus roseus</i> ..	1	4	128	—	—	—	—	1	—	—	—	—	1
8. <i>Acridothores tristis</i> ..	1	61	416	1	—	—	—	—	—	—	—	—	1
9. <i>Acridothores fuscus</i> ..	7	159	787	3	1	1	1	1	1	—	—	—	7
10. <i>Turdoides striatus</i> ..	11	267	447	5	9	—	—	1	1	1	—	—	17
11. <i>Turdoides affinis</i> ..	2	53	75	—	—	1	—	1	—	—	—	—	2
12. <i>Motacilla caspica</i> ..	1	11	97	—	—	—	—	—	—	—	—	1	1
Total ..	35	731	2340	16	15	1	5	8	1	1	—	—	47

Table 4. One interesting record is a nymph of *Hyalomma m. isaaci* from a wagtail, *Motacilla caspica*, a migratory bird.

Seasonal abundance of ticks on birds :

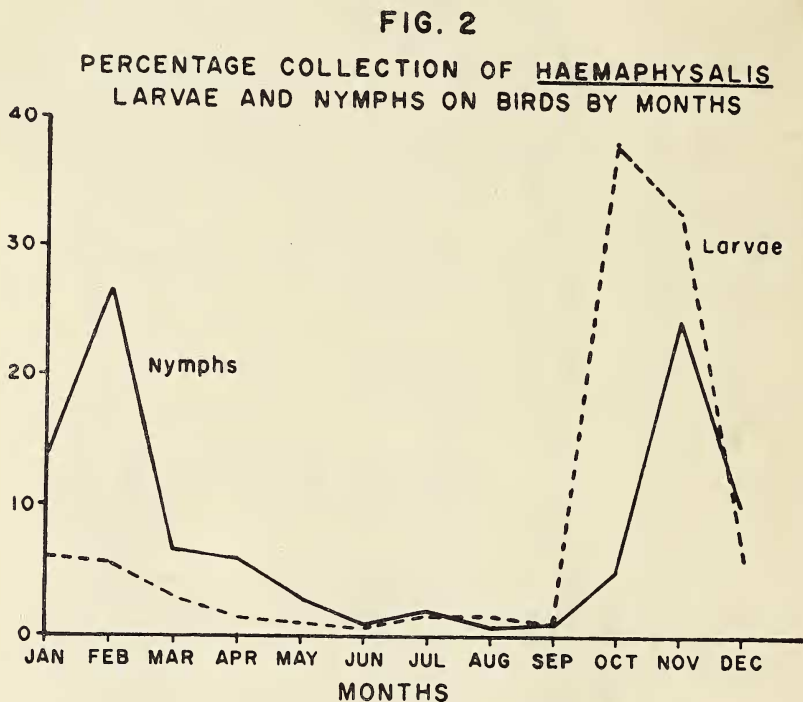
Table 5 presents the number of different species and stages of *Haemaphysalis* ticks collected on birds in different months. October and November are the months when very large numbers of larvae were found on birds (2911 and 2562 respectively). February was the month of nymphal abundance and July was the month when the largest number of adults were collected. This infestation pattern follows the pattern of general abundance of various tick stages in the study area (Rajagopalan *et al.*, loc cit., Fig. 2). It is significant to note that the larvae of *H. spinigera* and *H. turturis*, the two dominant species in ground drags in the study area, have been found on birds in all months of the year, including the monsoon season along with the larvae of *H. wellingtoni*, *H. bispinosa* and *H. intermedia*. For the purpose of analysis of the

TABLE 5

NUMBER OF *Haemaphysalis* TICKS, BY SPECIES AND STAGES, COLLECTED ON BIRDS IN DIFFERENT MONTHS
(Larvae/Nymphs/Adults)

	January	February	March	April	May	June	July	August	September	October	November	December
<i>H. spinigera</i>	295/193/1	139/210/2	50/57/1	13/22/0	2/11/0	10/0/0	16/0/0	48/2/0	44/2/0	2782/81/0	2321/356/2	399/185/0
<i>H. wellingtoni</i>	79/8/11	177/110/10	99/20/5	47/39/15	42/16/2	5/4/3	45/13/24	46/4/14	3/4/11	35/10/22	119/23/25	35/1/6
<i>H. turturis</i>	60/46/0	82/91/5	9/19/3	38/30/2	13/15/0	1/2/0	8/12/0	14/0/0	1/1/0	54/1/0	44/49/0	8/1/0
<i>H. bispinosa</i>	30/6/0	96/30/1	74/9/1	6/8/0	8/2/0	2/2/0	15/2/0	5/1/0	24/5/0	11/2/0	29/14/0	3/3/0
<i>H. intermedia</i>	1/2/1	8/2/1	6/9/1	14/3/0	17/2/1	21/2/0	30/0/6	3/0/2	1/0/3	7/0/0	4/3/0	4/0/1
<i>H. minuta</i>	2/8/1	1/6/3	0/5/0	0/1/0	—	0/0/1	0/0/7	0/1/0	0/1/0	—	0/1/0	0/1/0
<i>H. papuana</i>	30/3/0	21/8/0	0/1/0	1/1/0	0/1/0	—	1/0/0	—	—	15/0/0	38/1/0	13/2/0
<i>H. kinneari</i>	2/3/0	0/5/0	—	0/2/0	—	0/1/0	—	—	—	—	—	2/1/0
<i>H. aculeata</i>	0/1/0	1/0/0	0/2/0	5/2/0	0/0/1	—	0/1/0	—	—	—	—	—
<i>H. cuspidata</i>	3/2/0	1/21/0	3/0/0	1/1/0	—	—	—	—	—	7/0/0	7/4/0	5/0/0
<i>H. kvasanurensis</i>	—	0/0/1	—	—	—	—	—	—	—	—	—	—
<i>H. centropi</i>	—	—	—	—	—	—	—	—	—	—	—	—
<i>H. megalaimae</i>	—	0/8/11	0/0/2	1/1/3	—	0/0/1	0/1/2	—	—	0/0/5	0/6/3	—
Total	502/272/14	526/491/34	241/122/13	126/110/20	82/47/4	39/11/5	115/29/39	116/8/16	73/13/14	2911/94/27	2562/457/30	469/194/7

monthly incidence the number of ticks per 10 hosts examined was calculated from the infestation data on four species of ground frequenting birds, namely, *Centropus sinensis*, *Turdoides striatus*, *Turdoides affinis*



and *Copsychus saularis*, as only these four hosts species were examined in all months of the year (Table 6). The monthly incidence follows the pattern of general abundance in nature as described above, in the case of *H. spinigera* and *H. turturis*. In the case of *H. wellingtoni*, the larval and nymphal incidence do not appear in a strongly seasonal pattern, as all stages have been found in all months of the year. The adults are probably dropped in niches where the birds live or roost. Since the microecology of such niches remains almost constant throughout the year, the infestation of birds by different stages of *wellingtoni* might be expected to occur in all months of the year.

Table 7 presents the frequency distribution of *Haemaphysalis* ticks of all stages on birds. Nearly 39% of the birds positive for larvae had only one larva on each of them, and another 35% had 2-5 larvae on each. Only three birds had more than 200 larvae. The maximum number of larvae (324) was collected from a Jungle Babbler (*Turdoides striatus*) in the month of October. Fifty-seven per cent of the birds positive for nymphs had only one nymph on each of them and only one bird, *Gallus sonneratii* had 118 nymphs in the month of November. The

TABLE 6

MONTHLY INCIDENCE OF THE VARIOUS STAGES OF *H. spinigera*, *H. wellingtoni* AND *H. turturis* ON BUSH BIRDS¹.
DURING THE PERIOD DECEMBER 1959 TO NOVEMBER 1961

Month	No. hosts examined	Number of Ticks per 10 Hosts examined											
		<i>H. spinigera</i>				<i>H. wellingtoni</i>				<i>H. turturis</i>			
		L	N	A	Tot.	L	N	A	Tot.	L	N	A	Tot.
January	68	14.2	18.5	0.0	32.7	6.7	0.7	0.4	7.8	0.7	1.3	0.0	2.0
February	93	2.9	14.4	0.0	17.3	5.4	2.0	0.4	7.8	4.7	2.7	0.0	7.4
March	83	3.0	4.7	0.0	7.7	7.0	0.8	0.2	8.0	1.7	1.0	0.0	2.7
April	121	0.7	1.5	0.0	2.2	3.1	1.4	0.5	5.0	2.8	1.9	0.1	4.8
May	110	0.1	0.8	0.0	0.9	2.1	1.2	0.1	3.4	0.2	0.8	0.0	1.0
June	61	0.8	0.0	0.0	0.8	0.5	0.5	0.1	1.1	0.2	0.3	0.0	0.5
July	92	1.7	0.0	0.0	1.7	4.9	1.3	2.1	8.3	0.7	0.3	0.0	1.0
August	93	3.5	0.2	0.0	3.7	4.5	0.2	1.4	6.1	1.3	0.0	0.0	1.3
September	48	4.5	0.4	0.0	4.9	0.4	0.4	1.4	2.2	0.0	0.2	0.0	0.2
October	93	230.5	6.0	0.0	236.5	1.8	0.5	1.3	3.6	5.1	0.0	0.0	5.1
November	77	228.7	20.7	0.0	249.4	7.2	0.9	0.0	8.1	2.7	0.0	0.0	2.7
December	61	52.1	19.8	0.0	71.9	4.9	0.1	0.9	5.9	1.3	0.0	0.0	1.3

¹ For the purpose of this table, only four species of hosts were included *Centropus sinensis*, *Turdoides striatus*, *Turdoides affinis* and *Copsychus saularis*. These were the bush frequenting species which have been examined in good numbers in every month of the year.

same host species had the largest number of adults (17) collected in the month of July.

TABLE 7

FREQUENCY DISTRIBUTION OF *Haemaphysalis* TICKS OF ALL STAGES ON BIRDS EXAMINED DURING THE TWO YEAR STUDY, DECEMBER 1959 TO NOVEMBER 1961

Number of ticks	Number of birds in each category					
	with larvae		with nymphs		with adults	
	Frequency	Percentage of birds with larvae	Frequency	Percentage of birds with nymphs	Frequency	Percentage of birds with adults
1	300	38.9	293	57.6	58	58.5
2	137	17.4	78	15.3	17	17.2
3-5	147	18.6	87	17.1	18	18.1
6-10	66	8.3	35	6.9	5	5.1
11-50	110	13.9	13	2.6	1	1.1
51-100	14	1.8	2	0.4	—	—
101-200	13	1.7	1	0.1	—	—
201-300	1 }	0.4	—	—	—	—
301-400	2 }					
Total	790		509		99	
Maximum no. of ticks on one host	324		118		17	

The frequency of separate and mixed infestations of larvae, nymphs and adults of *Haemaphysalis* ticks of all species is summarized in Table 8. It is found that the birds with only larvae, with both larvae and nymphs and with only nymphs on them, were found in all months of the year. Birds with only larvae were found in much larger numbers during October and November and birds with only nymphs in February. These periods correspond respectively to months of peak larval and nymphal abundance in the forest, as evidenced by dragging operations.

For determining the favoured sites of attachment of ticks on birds only those ticks which were still attached at the time of examination were considered for analysis (Table 9). Most of the ticks were found on the head, neck and throat, vicinity of the beak, eyebrows and ear. A few ticks were also collected from the wings and one nymph from the anus. These ticks were of various species and no evidence was available as to the variation in site preference on the host for the individual tick species. Similar results were obtained by other workers also (Bishopp & Trembley 1945 ; Rosicky & Balat 1954).